Post-Combustion CO_2 Capture for Existing PC Boilers by Self-concentrating Absorbent

- **Funding Opportunity Number:**

DE-FOA0000131

- **Area of Interest B2:**

Solvents

- **Bench-Scale Development of**

Post-combustion CO_2 Capture

2010 NETL CO_2 Capture Technology Meeting, Pittsburgh, PA

Sep. 13-17 , 2010

- **Principal Investigator:**

  Dr. Liang Hu, 3H Company
- **Project Manager:**

  Dr. Gerald Choi, Nexant, Inc.
- **DOE Project Manager:**

  Mike Mosser
- **Participants:**

  E-ON U.S.

  Electric Power Research Institute (EPRI)

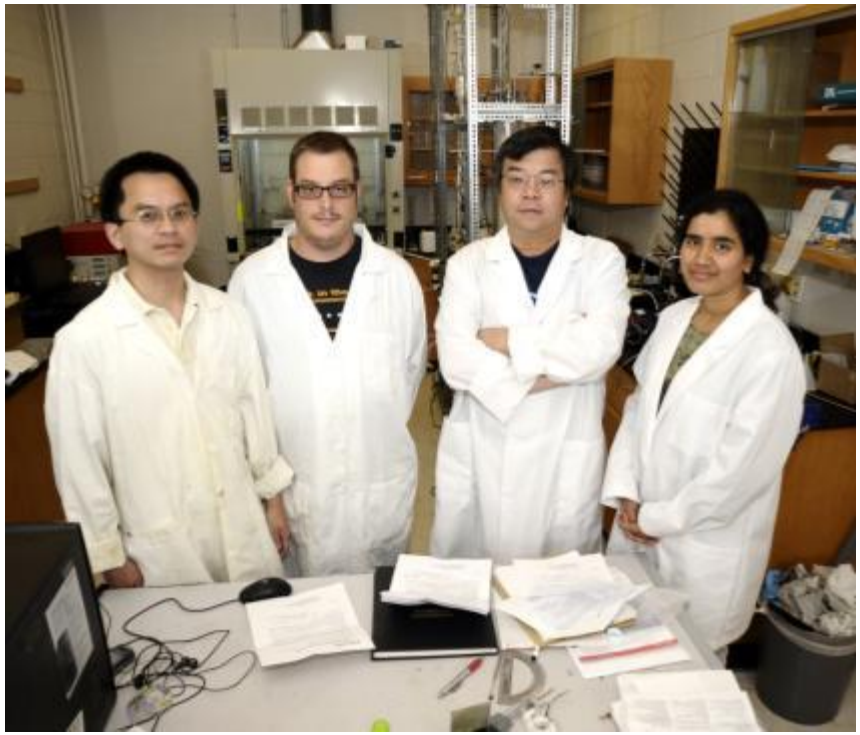
  Nexant, Inc.

  University of Kentucky

  3H Company

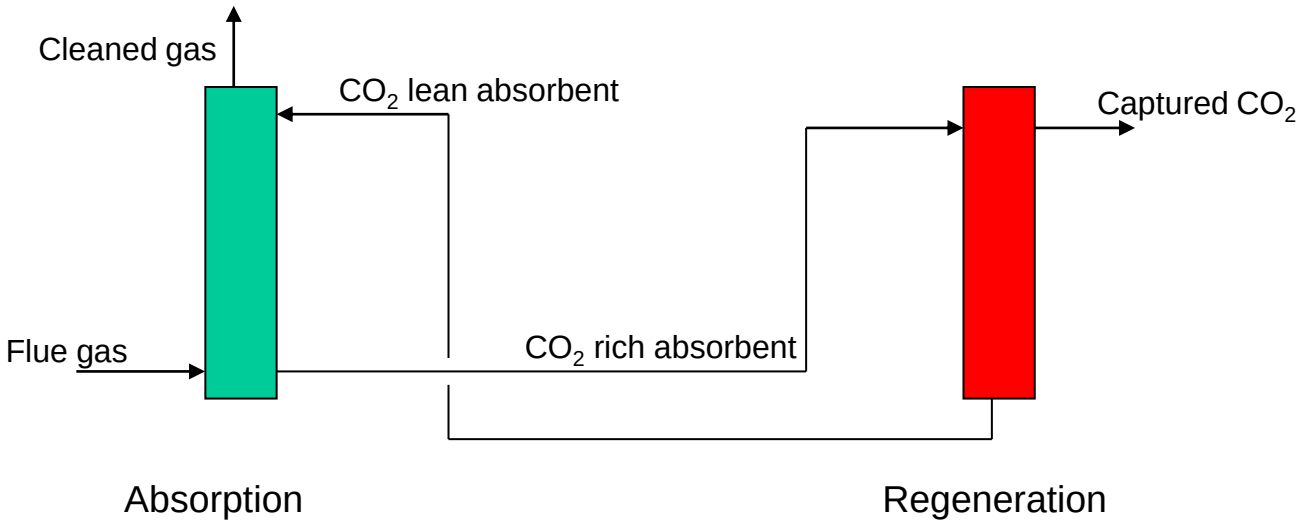
3H Company

- 3 H Company is an start-up technology company, located on the campus of University of Kentucky, Lexington, KY
- The core business is research and development (R&D) of CO_2 capture technologies



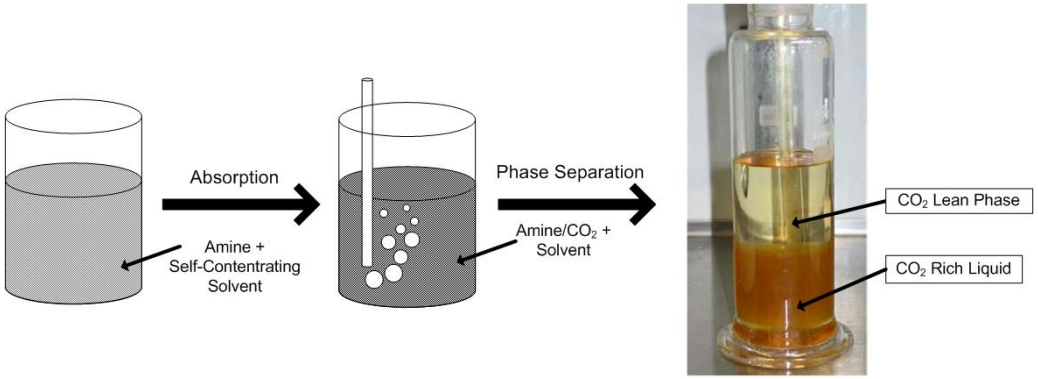
Conventional Solvent-Based CO_2 Capture Process is Very Energy Intensive

- Energy components: heat of reaction, sensible heat and vaporization heat
- Significant energy savings can be achieved with reduced solvent recirculation, and heat loss

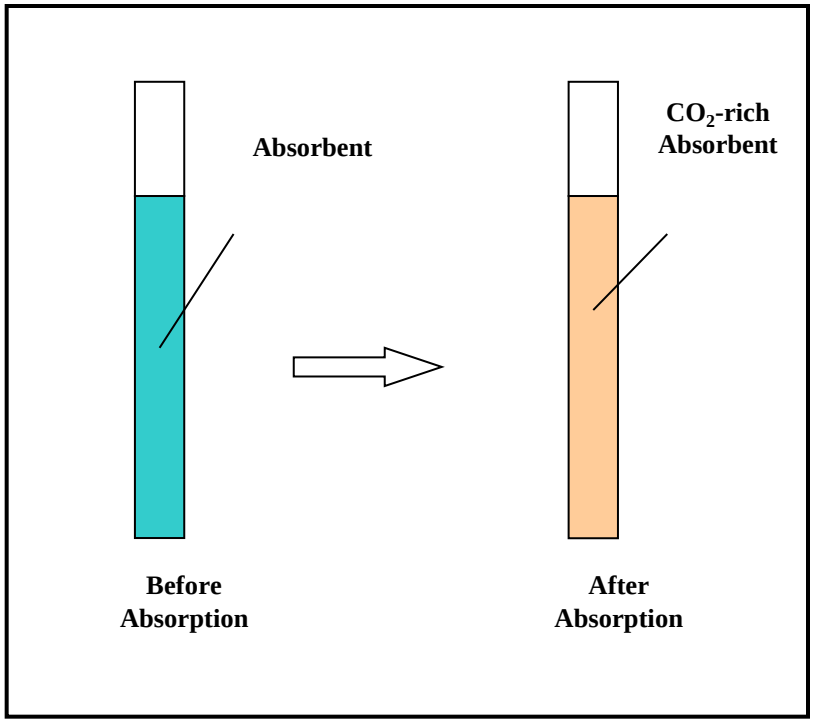


3H 'Self-Concentrating" CO_2 Capture Process

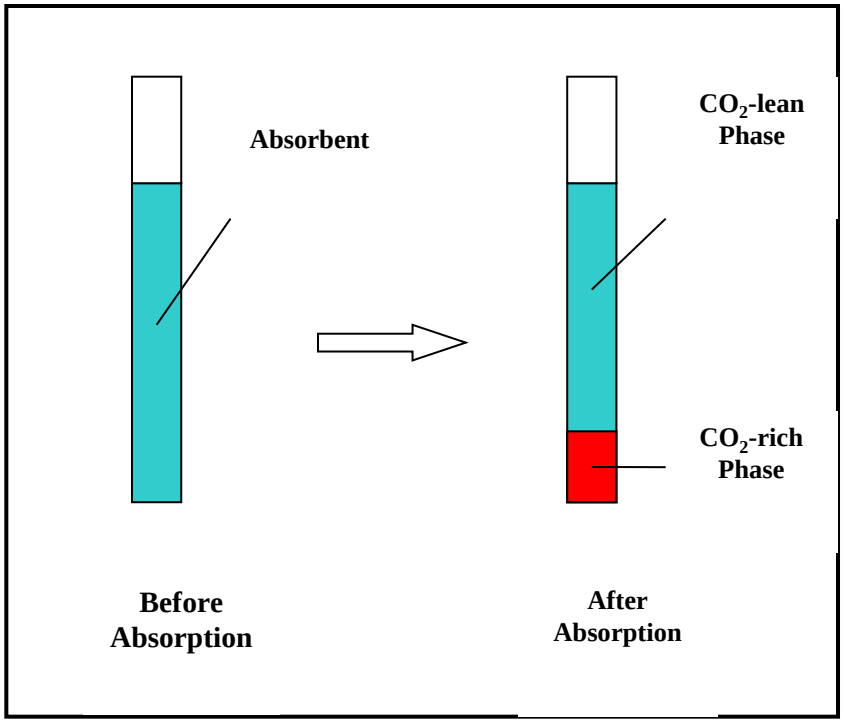
- The absorbent after absorbing CO_2 splits into two phases, CO_2 rich phase and CO_2 lean phase. After separating the two phases, CO_2 rich phase is sent to regeneration. After regeneration, the regenerated CO_2 rich phase combines with CO_2 lean phase to form absorbent to complete the cycle.
- Process demonstrated in the laboratory for specific absorbent/solvent pairs in bench scale vessel and scaled-model packed column.



The difference between 3H and a Conventional MEA CO_2 Capture process

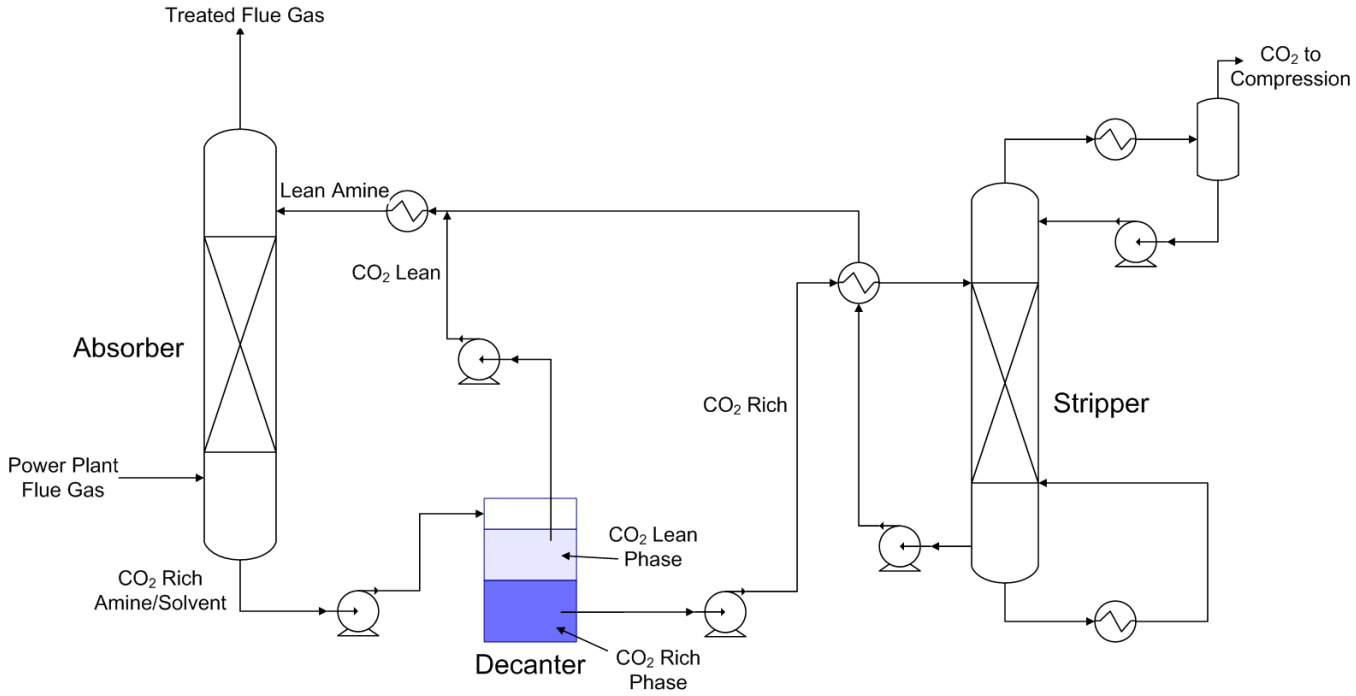


Benchmark MEA Absorption



Self-Concentrating Absorption

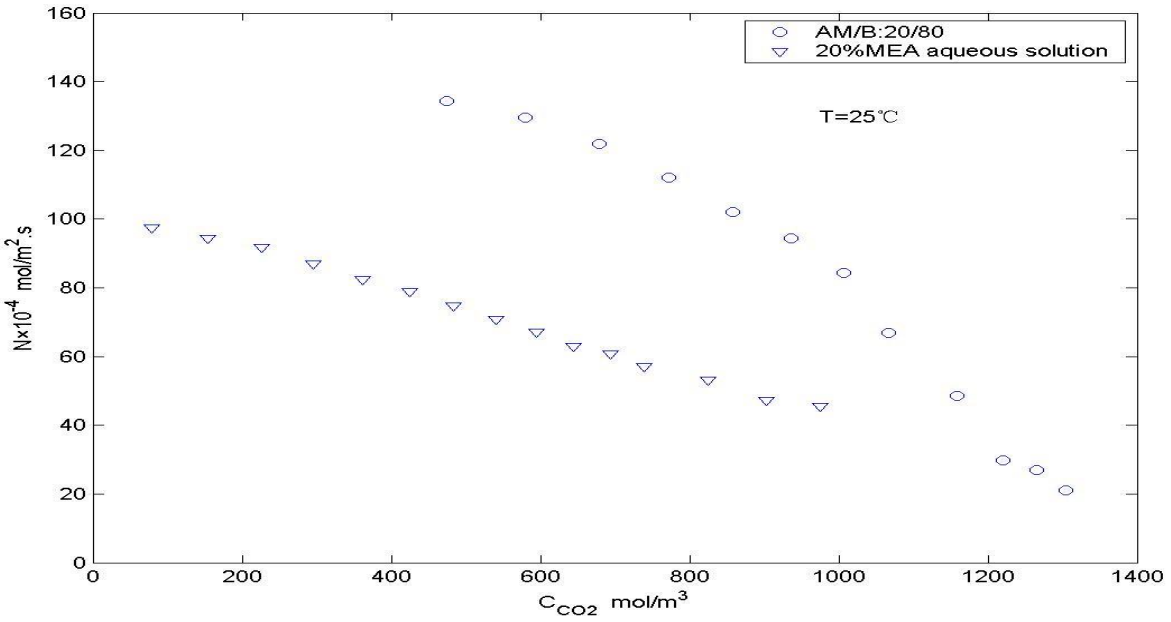
Conceptual Flow Scheme of a 3H 'Self-Concentrating" process



3H's Patents

- U.S. Patent No. 6,969,418, (11/2005)
- U.S. Patent No. 7,541,011, (06/2009)
- U.S. Patent No. 7,718,151, (06/2010)
- 5 pending patents

Preliminary Laboratory Results (CO_2 Absorption Rate)



[Conditions: 25 ^{o}C; P_{CO2} at 1 atm.; liquid agitation speed of 60 rpm; liquid volume=900 ml]

Preliminary Laboratory Results (Heat of Regeneration)

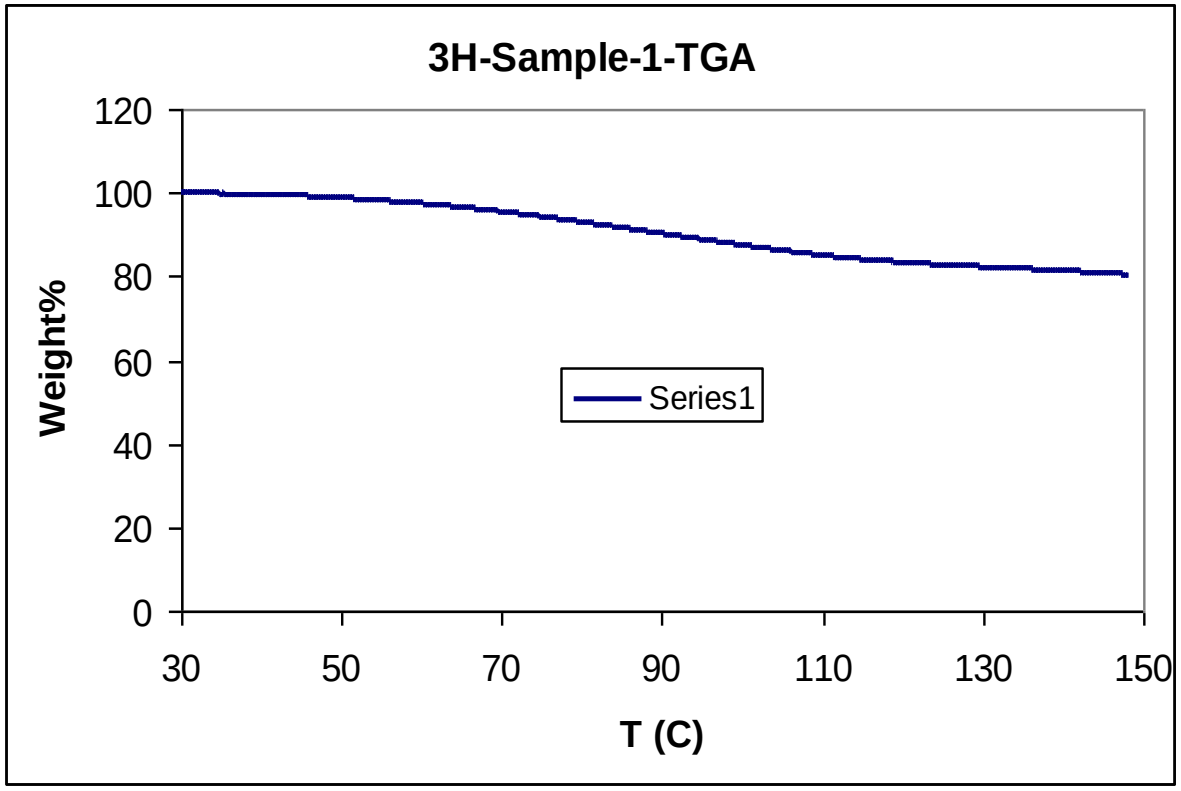
- **Benchmark MEA absorbent (30% aqueous solution)**
- **1934 Btu/lb of CO_2**

- **3H Technology**
- **Absorbent 1**

  587 Btu/lb of CO_2 (or 30% of Btu/lb of MEA)
- **Absorbent 2**

  287 Btu/lb of CO_2 (or 15% of the Btu/lb of MEA)

TGA Result for Concentrated CO_2 Rich Phase



Preliminary Laboratory Results (Regeneration at Lower Temperature)

Benchmark MEA absorbent (30% aqueous solution)

- 120 ^{o}C

Self-concentrating absorbent

- 90 ^{o}C

Preliminary Laboratory Results (CO_2 Loading Capacity)

Absorbent	**CO_2 Loading Capacity**
• Self-Concentrating Absorbent	0.27g CO_2/g absorbent
• Benchmark MEA	0.036g CO_2/g absorbent (20 % MEA)

- The CO_2 loading capacity was measured at 25^{o}C and 1 atm (99.9 % CO_2). The CO_2 loading capacity for benchmark MEA absorbent was taken from literature. The results show that the CO_2 loading capacity by the self-concentrating solvent is 7.5 times higher than that by Benchmark MEA absorbent.

Objectives of the Current DOE Funding Opportunity

- Experimentally and analytically confirm the techno-economic feasibility of the 'Self-Concentration' CO_2 Capture Process

- Develop an engineering design to construct and operate a slip-stream demonstration facility at one of E-ON's power plants in the U.S. as the next stage of technology development

Two-Phase R&D Approach

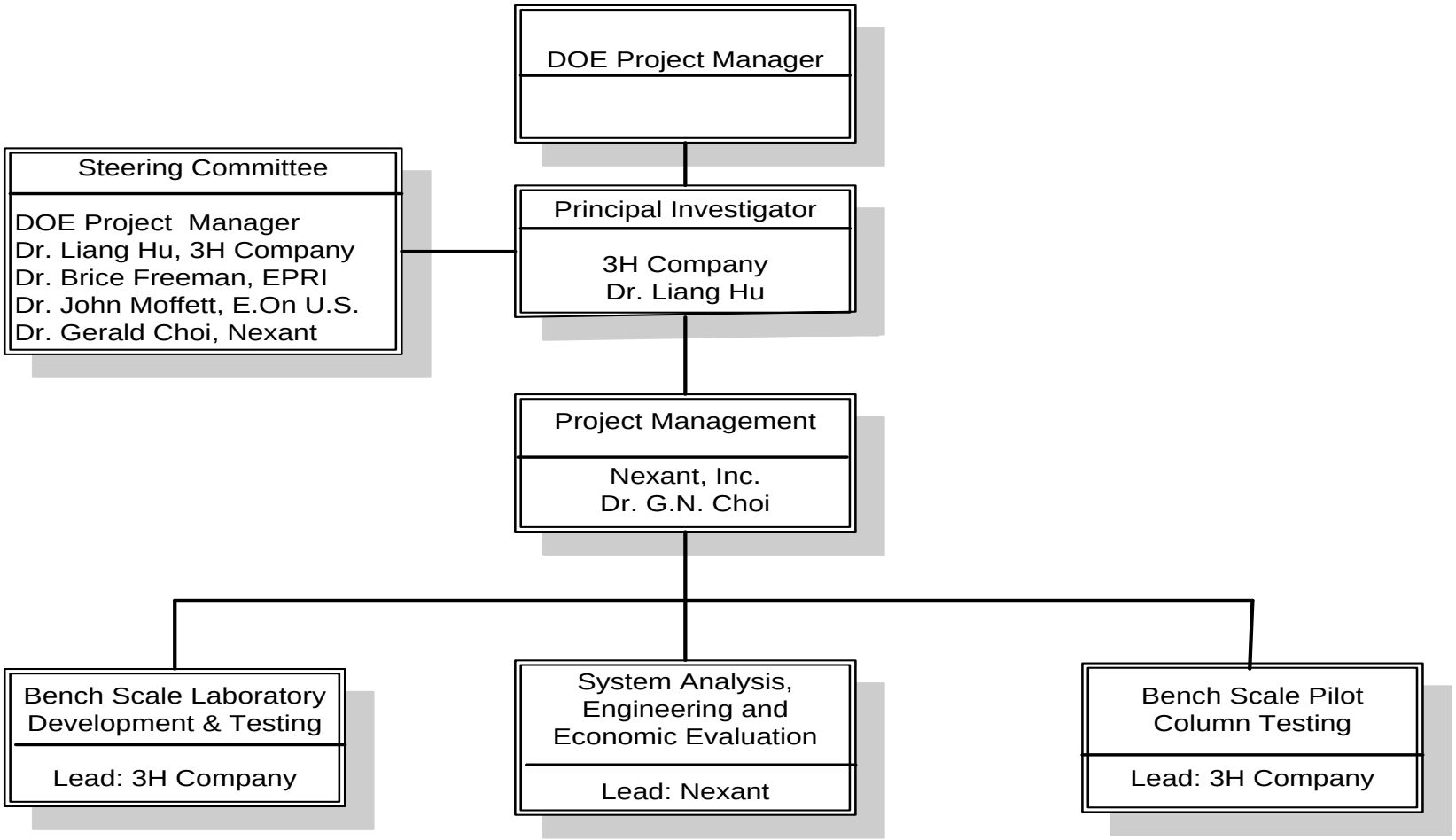
- Phase I is to focus on continuing laboratory screening experiments to identify different absorbent/solvent combinations that can exhibit the 'self-concentrating' CO_2 absorption effect, and conduct fundamental absorption/regeneration rates, physical and chemical property measurements to allow its process design and techno-economic feasibility to be evaluated.

- Phase II is to focus on conducting experiments to demonstrate the process under dynamic column testing conditions and to develop a process design package for a slip stream testing facility at a E-ON site.

Teaming Arrangement

- 3H Company – patent owner and developer of the Phase Transitional Absorption CO_2 capture technology
- Electric Power Research Institute (EPRI) – research arm of electric utility industry
- E.On U.S. – a U.S. subsidiary of E.ON, an electric utility company headquartered in Germany
- University of Kentucky (Advanced Science and Technology Commercialization Center) – the institution where 3H also has its research own laboratory
- Nexant, Inc. – a global energy consulting company

Project Organization



Program Funding Supports

- DOE
- Energy Power Research Institute (EPRI)
- E-ON U.S.

THANK YOU!

Dr. Gerald Choi, Nexant, Inc.
Mr. Brice Freeman, EPRI
Mr. John Moffert, E-ON/US
Mr. Mike Mosser, Andy Aurelio and Tim Fout,
DOE NETL
and
DOE NETL for the funding support